CHM129
Le Châtelier's Principle

Consider the following equilibrium:

$$Co(H_2O)_6^{2+}{}_{(aq)} + 4\ Cl^-{}_{(aq)} \leftrightarrow CoCl_4^{2-}{}_{(aq)} + 6\ H_2O_{(l)}$$
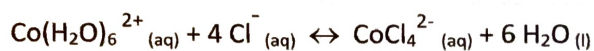
PINK   **BLUE**

Observe how the system respond to changes in concentration, volume and temperature:

1. Change in <u>Concentration</u>

   (a) Pour ~10mL of the Co solution into a 50mL beaker.

   (b) Increase the concentration of Cl^- by adding concentrated HCl to the solution. How does the system respond to this change?

   ↑ $[Cl^-]$: solution turns blue so system shifts to the right.

   @ equilibrium   Q = K

   if [reactant] increases   Q < K so system will shift right to approach equilibrium again.

2. Change in <u>Volume</u>

   (a) You can use the same solution from part 1b.

   (b) Increase the volume of the system by adding DI water (solvent) to the solution. How does the system respond to this change?
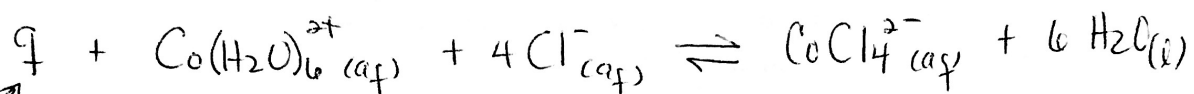
   ↑ V : solution turns pink so system shifts to the left. Adding water increases the volume of the solution and dilutes it. Similar to increasing the volume of a gas, the system will shift to favor moles moles of ions. In this case the system shifts left.

3. Change in __Temperature__

(a) This reaction is endothermic. If the temperature is increased, heat is added to the system. If the temperature is lowered, heat is removed from the system.

(b) Pour ~15mL of the Co solution into each of the test tubes. Place one of the test tubes in the hot water bath and the other in liquid nitrogen (do not let sit in liquid nitrogen for too long because the solution will freeze). How does the system respond to this change?

Reaction in endothermic   so

endothermic

$$q + Co(H_2O)_6^{2+}{}_{(aq)} + 4Cl^-{}_{(aq)} \rightleftharpoons CoCl_4^{2-}{}_{(aq)} + 6H_2O_{(l)}$$

* When placed in hot bath, solution turns blue
  ↳ system shifts right

* When placed in liquid nitrogen, solution turns pink
  ↳ system shifts left

For endothermic Rx

↑ T, adds heat, system shifts right ⟹ K will be larger (than before change)

↓ T, removes heat, system shifts left ⟹ K will be smaller (than before change)